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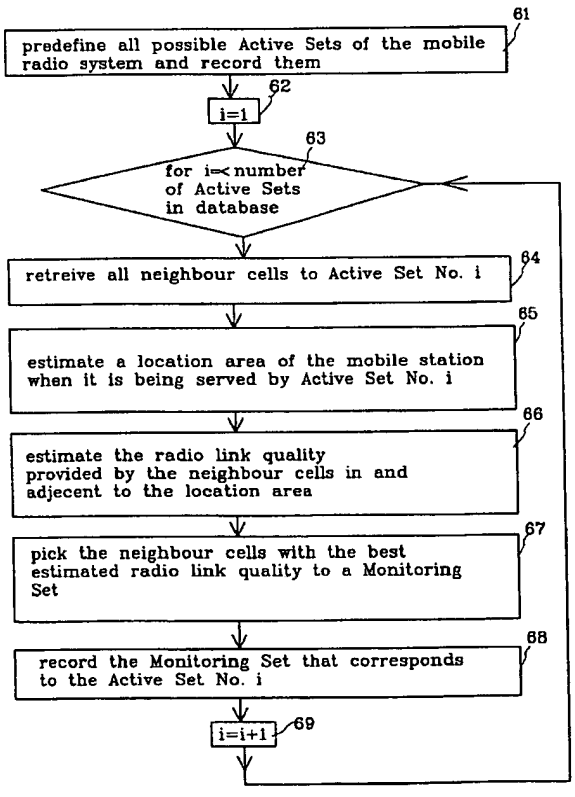
(54) Title: A METHOD AND A COMPUTER PROGRAM RELATED TO CELL ALLOCATION MANAGEMENT IN A MOBILE RADIO NETWORK



(57) Abstract: In mobile radio system supporting soft handover several cells that supports a dedicated radio channel with a mobile station are called the Active Set (AS). The mobile station measures the radio link quality of a set of cells called Monitored Set (Mos) and that are candidates for being included in the Active Set. If many cells are included in the Monitored Set the time to make a good measure of all cells will be long, and the time to perform handover will increase. However, the right cell need be is included in the Monitored Set to become included the Active Set. According to the present invention cells that have good radio properties in the mobile location area (ELA2) are selected for the Monitored Set and because this area is more restricted than the whole service area of the cells in the Active Set, a low number of cells need be included.

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A METHOD AND A COMPUTER PROGRAM RELATED TO CELL ALLOCATION MANAGEMENT IN A MOBILE RADIO NETWORK

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method related to a mobile radio system that enables soft handover to be performed within the system and a program unit related to cell management in such a system.

DESCRIPTION OF RELATED ART

A mobile radio system comprises a number of radio base stations each for providing communication services to a mobile station within a corresponding area called cell. Figure 1 shows some of the cells C of a mobile radio system. In the mobile radio system a dedicated radio channel is set up to a mobile station for communication service. Figure 2 shows the mobile station MS and its dedicated radio channel DCH to a radio base station BTS in the fixed part of a cellular mobile radio system. The fixed part comprises more nodes than the radio base station BTS that serve to connect the radio base station BTS to other communication systems and that control the communication, however, these further nodes are not shown in figure 2.

In conventional mobile radio systems based on FDMA (Frequency Division Multiple Access) or TDMA (Time Division Multiple Access) technology the dedicated radio channel DCH is set up in just one cell, which is the serving cell C1 shown in figure 1. When an other cell, i.e. target cell, C2 can provide better radio link quality then the cell C1 handling the dedicated radio channel DCH, a new dedicated radio channel is set up in the target cell C2 for the communication with the mobile station MS. The communication with the mobile station MS is switched over to new dedicated

radio channel DCH and the old one in the prior cell C1 is released. The switch of serving cell C1,C2 for handling the communication is called handover.

The radio environments of the mobile station MS changes due to the traffic load of the mobile radio system varies and due to the mobile station MS moving around and the radio propagation thereby changes. In order to enable good radio link quality and reduce the interference in the mobile radio system it is essential that the dedicated radio channel DCH is set up in the right cell. To find out which cell C is the right the mobile station MS performs measurements on the radio link quality on downlink radio channels, i.e. radio channels in the direction to the mobile station MS, of candidate cells C as well as the serving cell C1. However, these measurements require receiving and computation capacity from the mobile station MS. They also need to be updated often in order to correspond to the changing radio environments. If too few cells are measured there is a risk that the right cell C is not detected on one hand. If, on the other hand, too many cells C are measured it will take a long time to get a good measure of the radio link quality of all the cells C. Both cases result in a degradation of the system performance. Especially in situations when the radio link qualities change rapidly, e.g. when the mobile station MS turns around a street corner in speed, it is essential to find the right cell quickly. The number of measured cells is therefore limited to just the neighbour cells NC of the serving cell C1.

The operator of the mobile radio system provides a list of neighbour cells NC for each of the cells C, C1, C2 in the system. The mobile radio system communicates this list of neighbour cells NC with the mobile stations MS. Thereby, the mobile station MS having a dedicated radio channel within the serving cell C1 is informed on which cells NC is shall make radio link measurements.

In mobile radio systems based on CDMA (Code Division Multiple Access) technology more than one cell C can support a dedicated radio channel DCH to the mobile station MS. When a new cell C shall support the dedicated radio channel the support is maintained in the previous cell at least until the dedicated radio channel is established in the new cell C. This is called soft handover. The handover mechanism used in TDMA mobile radio systems is sometimes referred to as hard handover because the dedicated radio channel in the previous cell is released before the dedicated radio channel in the new cell is established.

A basis for enabling the soft handover is the fact that the same dedicated radio channel DCH is used by all cells supporting the communication. This in turn enables the dedicated radio channel DCH to be maintained at the previous cell while the dedicated radio channel DCH is established in a new cell. The cells supporting the mobile station MS with the dedicated radio channel DCH define an Active Set. Figure 3 shows the cells C of a CDMA system and an Active Set AS of three cells are given a striped hatch mark.

The mobile station MS measures the radio link quality on the pilot channel of the cells in the Active Set AS. In the same way the mobile station MS also measures the radio link quality of cells C that are candidates to be included in the Active Set AS. The candidate cells C to be measured by the mobile station MS are referred to as a Monitored Set MoS, se figure 3.

In mobile radio systems based on CDMA technology the cells C use the same frequency band for communication. It is therefore even more essential to find the right cell or cells for serving the mobile station MS compared to systems based on TDMA or FDMA technology. If the mobile station MS is not served by the right cell or cells, its transmission power will be higher then necessary. This is due to the

serving cell adjusts the power of its mobile stations MS in order to receive the same power level from all its mobile stations MS. When the right cell, i.e. the cell receiving the highest signal strength from the mobile station MS, is not serving the mobile station MS it cannot adjust the output power of the mobile station MS. The power will be adjusted by the serving cells that experience a lower signal strengt. The mobile station MS thus unnecessary increases the noise level in the right cell and that in turn reduces the capacity for uplink reception in the right cell.

IS-95 (Interim Standard 95) is a standard for a mobile radio system based on CDMA technology and is mainly employed in the USA. In mobile radio systems based on IS-95 standard, the fixed part of the Mobile Radio System informs the mobile station MS of which cells are included in the Monitored Set MoS. Whenever a new cell is included in the Active Set AS new cells C are added to the Monitored Set MoS or when a cell C is released from the Active Set AS cells C are also excluded from the Monitored Set MoS. As all of the cells C in the Active Set AS each have a number of neighbour cells NC the number of cells C in the Monitored Set MoS will be large when all neighbour cells NC are included in the Monitored Set MoS. In order to perform the difficult task of measuring the cells of the Active Set AS and the Monitored Set MoS more easily and quickly, the IS-95 standard specifies that all radio base stations BTS are given the same pilot code and are mutually synchronised in absolute time; however, the spreading code phase is shifted between the cells C. The mobile station MS is informed of the phase shift of the relevant cells C and when it has synchronised to any of the cells C, it quickly tunes into the phase of the pilot code of any of the other cells C.

WCDMA (Wideband Code Division Multiple Access) is a commonly used word for the 3GPP (Third Generation Partnership Project) standard for the FDD mode of UTRAN (UMTS

Terrestrial Radio Access Network). The standard for WCDMA does not require the radio base stations BTS to be synchronised in absolute time and the cells C are all given separate pilot codes. In fact the different pilot codes are the significant recognition mark of the different cells C. When a mobile station MS shall measure a specific cell C it first have to synchronise to the specific pilot code transmitted in the cell C of interest.

According to WCDMA standard the Active Set AS can comprise up to 6 cells C. The WCDMA standard also specifies that the fixed part of the mobile radio system shall inform the mobile station MS of the Monitored Set MoS. Including a large number of cells C in the Monitored Set MoS will put a heavy burden on the mobile station MS for measuring the radio link qualities, and this will reduce the frequency at which the measurements of the cells are updated.

SUMMARY OF THE INVENTION

The present application addresses the problem of identifying the right cells to be incorporated in the Active Set, when the capacity for measuring the radio link quality of the cells is limited.

The present invention solves the problem by a method for finding the most appropriate cells to be incorporated in the Monitored Set. From the Monitored Set new cells to be incorporated in the Active Set will be selected. The inventive method is based on the insight that the area in which a mobile station will be located when served by an Active Set is more restricted than the total service area of each cell within the Active Set, and that in the restricted area the radio interaction with surrounding cells will not correspond to the interactions that may occur in the total area of the cell or cells of the Active Set.

According to the inventive method an Active Set is determined for providing the mobile station with a dedicated radio channel. When the mobile station will be served by the Active Set, the radio link will effect other cells and will be effected by other cells. This radio interaction with other cells is estimated according to the method. A Monitored Set is determined, based on the estimation thus produced, and comprising the cells that have the strongest interaction with the mobile station. The mobile station will measure the radio link quality of the cells of the Monitored Set, when the mobile is served by the Active Set.

The invention is also related to a system arranged to perform the inventive method.

The invention is also related to a program unit for carrying out steps similar to the method.

The inventive method has the advantage of including just those cells in a Monitored Set that are truly candidates for being included in the Active Set. Unsignificant cells are thus not measured. Thereby the Monitored Set will be measured more quickly, and that in turn enables an early handover decision.

Another advantage of a limited number of cells being included in the Monitored Set is that the control communications between the mobile station and the fixed part of the mobile radio system will be less when less cells need be reported over the radio link. Moreover the radio link protocol for communicating sets a limit on the number of cells possible to inform to the mobile station for measuring purposes, i.e. the number of cells in the Monitored Set and the Active Set.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a view of cells in a mobile radio system.

Figure 2 is a block diagram over a radio base station and a mobile station.

Figure 3 is a view of cells in a mobile radio system supporting soft handover.

Figure 4 is another view of cells in the mobile radio system an Active Set of one cell.

Figure 5a is another view of cells in the mobile radio system and an Active Set of two cells.

Figure 5b shows the same view of cells as figure 5a but in with an additional cell included in the Active Set.

Figure 6 is a flow diagram of the steps of the inventive method.

Figure 7 is a block diagram of nodes in a radio access network.

DESCRIPTION OF PREFERRED EMBODIMENTS

Figures 4, 5a and 5b shows a number of cells C shaped in a way that better corresponds to the actual service area of the cells C than the hexagon pattern of cells C shown in figures 1 and 3. The serving areas of the cells C partly overlap. The total number of cells C shown are however just a few of all cells C in a whole cellular mobile radio system that supports soft handover. Two of the cells C in figure 5a are given the same striped hatch mark and makes up a second Active Set AS2 that provides a dedicated communication channel DCH to a mobile station MS. The mobile station MS is however just shown in figure 2.

Figure 5b shows the same cells C as figure 3, however, a third Active Set AS3 serves the mobile station MS with a dedicated radio channel DCH in all its cells C. The change of Active Set is caused by the mobile station MS roaming in the area covered by the cells C which implies changes of the radio environments of the mobile station. When a new cell C is considered to provide good radio quality it is included in the Active Set which then is called the third Active Set AS3 and differs from the second Active Set AS2 only in that the additional cell C is included. An other reason for including the new cell C in the third Active Set AS3 is that the transmission from the mobile station MS would otherwise jam the uplink reception in the new cell. By including the cell in the Active Set AS3 the mobile transmission power can be adjusted in response to the power received from it in the new cell.

Figure 4 shows a first Active Set comprising just one cell and all its neighbour cells C.

In this particular example a new cell C is added to the Active Set AS3, but of course, a cell C could instead be released if it was detected that it did not perform well.

The addition of cells C to the Active Set AS1, AS2, AS3 is based on measurements made by the mobile station MS on cells C of the Monitored Set MoS1, MoS2, MoS3 and on the cells C of the Active Set AS1, AS2, AS3. The measured quality of the cells in the Monitored Set MoS1, MoS2, MoS3 compared to that of the cells of the Active Set AS1, AS2, AS3 determines whether new cells C should be included in the Active Set AS1, AS2, AS3 or not.

A principle of the present invention is that each Active Set AS2, AS3 shall be associated with a corresponding Monitored Set. Figure 4 shows a first Monitored Set MoS1 comprising all neighbour cells C of the first Active Set AS1 except for

one, the a first Monitored Set MoS1 is given a second striped hatch mark. Figure 5a shows a second Monitored Set MoS2 that is associated with the first Active Set AS2 and comprises a number of cells C that also are given the second striped hatch mark and. Figure 5b shows a third Monitored Set MoS3 that are also given the second hatch mark.

The Monitored Set MoS1, MoS2, MoS3 defines the cells C which the mobile station MS shall measure when served by the associated Active Set AS1, AS2, AS3.

Figure 6 shows the steps of an inventive method for defining a Monitored Set MoS1, MoS2, MoS3 to be associated with an Active Set AS1, AS2, AS3.

It is presumed that a cell plan has been made for the mobile radio system before the method is carried out. The cell plan includes a record of all cells C, the various pilot codes used as identification in the cells C and the neighbour cells NC of each cell in the plan.

In a first step 61, all possible Active Sets AS1, AS2, AS3 are predetermined and recorded in a database that also comprises the cell plan.

Possible Active Sets AS1, AS2, AS3 are formed by 1 up to 6 cells C linked by neighbour relations. Active Sets AS1 comprising just one cell corresponds to the cells already recorded in the database and therefore need not be further defined. Initially Active Sets AS2 comprising two cells are therefore determined. Starting by the first cell recorded in the database new Active Sets AS2 of two cells are formed by combining said first cell and each of its neighbour cells C. For each cell C in the record new Active Sets AS2 of two cells C are formed correspondingly. However, previously recorded combinations are not recorded again.

Secondly, all Active Sets AS3 comprising three cells C are determined. Starting from the first recorded Active Set AS2 of two cells C all combinations with any of the neighbour cells C to the two cells are recorded as an Active Set AS3. For each Active Set AS2 of two cells C the combination with each of its neighbour cells C is repeated, however, combinations of three cells previously recorded are not recorded again.

In the same way all combinations of four, five and six cells C are determined as Active Sets AS2, AS3.

When all combinations are found, the number of Active Sets AS2, AS3 are counted.

A number of steps 64-68 will then be repeated for each of the Active Sets AS1, AS2, AS3 in order to allocate a Monitored Set MoS1, MoS2, MoS3 to each of the Active Sets AS1, AS2, AS3. An index i is used for defining which of the Active Sets AS1, AS2, AS3 that is being handled in the following steps 64-68. In the second step 62 the index i is set to 1, and in this example the first Active Set AS1 happens to be the first Active Set in the record and is thus selected when index is set to 1.

In a following third step 63 it is checked that the index i do not exceed the maximum number of Active Sets AS1, AS2, AS3 in the database, and when this is true a fourth step 64 is carried out.

In the fourth step 64 all cells C that are neighbour to any of the cells of the first Active Set AS1 are retrieved.

Next, in a fifth step 65, an area is estimated within which the mobile station MS will be located when it is served by the actual Active Set AS1, which for index 1 is the first Active Set AS1. In figures 4, 5a and 5b the estimated location areas ELA1, ELA2, ELA3 are filled with black. The

location areas ELA1, ELA2, ELA3 are the areas within which the mobile station MS is estimated to be found when it is served by the corresponding Active Set AS1, AS2, AS3. The first location area ELA1 corresponds to the first Active Set AS1. A wave propagation prediction tool is used to make the estimation of the location area ELA1.

In a sixth following step 66 is estimated the radio link quality that the neighbour cells C provides in the location area ELA1 or adjacent to it. Also the interference in the neighbour cells NC caused by the transmission from the mobile station MS is estimated. The expression radio interaction is used for both phenomena, i.e. the interference caused in the neighbour cells by a dedicated radio channel between the mobile station MS and the Active Set AS1, AS2, AS3 as well as for the radio link quality to be provided by the other cells in the location area ELA2, ELA3.

Next, in the seventh step 67, the result from the estimation in the sixth step 66 is used for selecting the cells C for the first Monitored Set MoS1. Cells C that have a capability of providing a good radio link quality in or adjacent to the first location area ELA1 are selected. Cells C that can be exposed to a high interference from the dedicated radio channel DCH in the first Active Set AS1 are also selected. In this example all neighbour cells C except for one are included in the first Monitoring Set MoS1. As can be understood also from figure 4, the cell that is omitted from the first Monitoring Set MoS1 will become candidate for the first Active Set on condition that the mobile station MS is in a location covered by both the cell of first Active Set AS1 and by any of two the cells that are neighbour to both to the first Active Set AS1 and the omitted cell. However, when the mobile station MS is so located it is not any longer served by the first Active Set AS1, at least two

cells are included in the Active Set that then will serve the mobile station.

In an eight step 68 following the first Monitored Set MoS1 is recorded in the database with reference to the first Active Set AS1.

Thereby all the steps for finding a first Monitored Set MoS1 for the first Active Set AS1 are carried out. Last in the loop, see ninth step 69, the index i is incremented with one for the next Active Set recorded in the database to be allocated a Monitored Set. The third step 63 is then carried out again. The loop will be repeated until all Active Sets AS1, AS2, AS3 have been allocated a corresponding Monitored Set MoS1, MoS2, MoS3. When the index i is incremented to a number that points at the second Active Set AS2, the second location area ELA2 will be estimated in the fifth step 65. The second Monitored Set MoS2 will be defined in the seventh step 67, and recorded with a reference from the second Active Set AS2 in the eight step 68. Correspondingly the third location area ELA3 is estimated and the third Monitored Set MoS3 defined and recorded when the third Active Set AS3 is handled in the loop.

The location areas ELA1, ELA2, ELA3 that are estimated in the fifth step 65, are smaller than the total service area of the cell or cells that are included in the corresponding Active Set AS1, AS2, AS3. The inventive method takes advantage of these location areas ELA1, ELA2, ELA3 are being smaller than the total service area of the cells C of the Active Sets AS1, AS2, AS3 and determines the Monitored Sets MoS1, MoS2, MoS3 from the estimated location areas ELA1, ELA2, ELA3 instead of the area of the total of cells of the Active Sets AS1, AS2, AS3.

In order to make the estimation of location area ELA1, ELA2, ELA3 in the fifth step 65, the threshold values or the

relative values of signal strength for including or omitting a cell C from the Active Set must be known as well as the handover algorithm. The border of the location area ELA1, ELA2, ELA3 corresponds to where the predicted signal strengths are equal to the threshold values or to the relative values.

In figure 7 is shown the mobile station MS and two radio access networks RNS according to the standard UTRAN (UMTS Terrestrial Radio Access Network) for WCDMA technology. The radio access networks RNS correspond to the mobile radio system except for the mobile station MS. The radio access networks RNS are thus also referred to as the fixed part of the mobile radio system in this description. In figure 7 is also indicated the dedicated radio channel DCH between the mobile station MS and one of the radio access networks RNS. The radio access network RNS comprises several radio base stations BTS, and a radio network controller RNC. All the radio base stations BTS are connected to the radio network controller RNC and the radio network controllers RNC are connected to a router and or a switch in a core network. However, just the connections to the core network are indicated in figure 7. The radio network controller RNC are also interconnected to enable soft handover between cells in different radio access networks RNS.

The database DB comprising the cell plan and the list of Active Sets AS1, AS2, AS3 and Monitored Sets MoS2, MoS3 is also shown in figure 7 as well as a tool TL for selecting the Monitored Set MoS2, MoS3 and map database MDB. The database DB is connected to the radio network controller RNC as well as to the radio base stations BTS and to the tool TL. The tool TL is also connected to the map database MDB.

The list of Active Sets AS1, AS2, AS3 and corresponding Monitored Sets MoS1, MoS2, MoS3 and the cell plan are downloaded to the radio network controller RNC from the

database DB. When the mobile radio system has decided that the second Active Set AS2 shall serve the mobile station MS, the list is used by the radio network controller RNC to inform the Mobile Station MS of the actual Monitored Set MoS2. The mobile station MS measures the radio link quality of the cells C of the Monitored Set MoS2 as well as the Active Set AS2 and reports the result to the radio network controller RNC. The radio network controller RNC evaluates the measurements to decide on handover. When a decision is made to let the third Active Set AS3 serve the mobile station MS, the radio network controller RNC sends commands to the radio base stations BTS involved and to the mobile station MS. When the handover is performed the mobile station MS is informed of the third Monitored Set MoS3.

The tool TL comprises a wave propagation prediction function used in the fifth and sixth step 65, 66 of the method described with reference to figure 6. The tool TL includes a computer programmed to retrieve information on topography from the map database MDB and information on the sites, the power and the antennas of radio base stations BTS from the database DB. The tool TL estimates wave propagation and interference propagation in the cells C of the cellular mobile radio system. The tool TL is also programmed to estimate the location areas ELA1, ELA2, ELA3 based upon the estimated wave propagation and on information on the handover algorithm and on threshold values for handover that are retrieved from the database DB. An estimate of which cells C to provide high signal strength in the area of the mobile station MS or in its adjacent area is also made by the tool TL.

Optionally the selection of cells C for the Monitored Sets MoS2, MoS3 is further improved by measurements made in the mobile radio system. The measurements results are first recorded in the radio network controller RNC and then sent to the database DB to be retrieved by the tool TL when

deciding on the Monitored Sets MoS1, MoS2, MoS3. The signal strength measurements are made by special receivers that rove in the service area of the cellular mobile radio system and records signal strengths from different radio base stations BTS with reference to the receivers position and the cell identification. The results are then recorded in the database. The database is arranged to control these optional measurements to be performed and functions to evaluate the results and statistics thus collected. The database comprises processing and controlling means to this end.

Alternatively to or in addition to the measurements made by the special receivers, measurements made by the mobile station MS and reported to the radio network controller RNC are recorded in the database to be used in the selection of the Monitored Set. The measurements recorded are the signal strength and link quality of the cells of the Monitoring Set MoS1, MoS2, MoS3 with reference to the Active Set AS1, AS2, AS3 serving the mobile station MS. In order to be able to find new candidates for the Monitoring Set some of the mobile stations MS are informed of an extended Monitored Set. The extended Monitored Set comprises one or more neighbour cells to a serving Active Sets that are normally not included in the Monitored Set MoS2, MoS3. The measurements on the additional cells C are reported to the radio network controller RNC and are recorded in the database DB, and then used by the tool TL to find out if any of these additional cells C shall be included in the Monitored Set MoS1, MoS2, MoS3.

Optionally also events like handovers are recorded in the database with reference to the serving Active Set AS1, AS2, AS3 and with information on the target Active Set AS1, AS2, AS3. In addition to the successful handovers also unsuccessful handovers and reason for the handover fail are

recorded. These events are also used for the selection of cells C for the Monitoring Sets MoS1, MoS2, MoS3.

Other types of events that optionally are recorded for the same purpose are the dropped call rate, the rate of failure when a common channel is switched to a dedicated radio channel and then is served by an Active Set AS2, AS3 of more than on cell. A further optional event to record is the interference level increasing a threshold value. The Active Set AS1, AS2, AS3 that serves the mobile station MS when any of these different types of events occur shall also be recorded. For downlink interference, i.e. interference from a base station BTS to a mobile station MS, that increases the threshold, the mobile station MS shall be instructed to detect which cell C that produces the interfering signal and report this cell to the fixed part of the mobile radio system. Uplink interference level higher than the threshold value is detected in the radio base station BTS. When this occurs the radio base station BTS shall also detect which mobile station MS is producing the interfering signal by finding its spreading code. When the spreading code is found it and the fact that the interference is above the threshold value is reported to the RNC. The RNC finds the Active Set AS1, AS2, AS3 that serves the mobile station MS and records it and the base station BTS that is exposed to a interference level above the threshold in the database DB.

Optionally the selection of cells C for the Monitored Set MoS1, MoS2, MoS3 is also improved by the operator of the mobile radio system. The operator, may, e.g. add a cell C along a route often travelled by mobile station MS users and instead omit a cell C that is less likely for the mobile station MS to be moved into.

Alternatively to base the selection of cells for the Monitoring Set MoS1, MoS2, MoS3 on wave propagation estimations with option to further improve the selection by

the information collected from the traffic in the real mobile radio network, the selection of cells is wholly based on information collected from the traffic in the real mobile radio network. This information may include the operators knowledge of where traffic is generated, with respect to routes and highways etc. For such a case, i.e. when no wave propagation prediction tool is used, the location area ELA1, ELA2, ELA3 of the mobile station MS will not be expressly estimated. However, the minimisation of cells in the Monitored Set MoS1, MoS2, MoS3 is still based on the fact that the location area ELA1, ELA2, ELA3 is smaller than the total service area of all cells included in the Active Set AS1, AS2, AS3.

The tool TL is programmed to carry out the method illustrated in the sixth step of the method, se 66 in figure 6, and retrieve information necessary from the database DB and the map database MDB.

CLAIMS

1. A method related to controlling the allocation of cells (C) for providing a dedicated radio link (DCH) to a mobile station (MS) in a mobile radio system comprising the step of,

a) determining (61) an active set (AS1, AS2, AS3) of two or more cells (C) for allocating a dedicated radio link (DCH) to the mobile station (MS);

c h a r a c t e r i s e d in the further steps of:

b) estimating (65,66) the radio link quality to be provided by other cells (C) than the cells of the active set and estimating the interference caused in said other cells (C) by the dedicated radio link (DCH) when the mobile station (MS) is served by the two or more cells of the active set (AS1, AS2, AS3);

c) determining (67) a monitored set (MoS1, MoS2, MoS3) of a limited number of said other cells (C) based upon the estimation in step b.

2. The method claimed in claim 1 wherein step a is c h a r a c t e r i s e d in that all possible active sets (AS1, AS2, AS3) in the mobile radio system are predetermined, wherein the cells (C) of a possible active set (AS1, AS2, AS3) are linked by neighbouring relations, and wherein in step c for each of the active sets a corresponding monitored set (MoS1, MoS2, MoS3) is predetermined.

3. The method of claim 2 wherein the predetermined active sets (AS1,AS2,AS3) and the corresponding predetermined monitored sets (MoS1,MoS2,MoS3) are recorded in a database (DB).

4. The method of claim 1 wherein said other cells (C) are the neighbour cells (C) of the cells of the Active Set (AS1, AS2, AS3).

5. The method of claim 1 further comprising the step of:

informing the mobile station MS of the monitored set (MoS1, MoS2, MoS3) when a change of active set (AS1, AS2, AS3) is made.

6. The method of claim 1 wherein the estimation in step b is based upon statistics collected from the information in measurement reports from several mobile stations MS of the mobile radio system.

7. The method of claim 6 wherein some of the mobile stations (MS) are informed of an extended monitored set (MoS1, MoS2, MoS3) comprising more cells than those determined in step c, in order to collect statistics.

8. The method of claim 1 wherein the estimation in step b is based upon statistics collected by the mobile radio system on events occured in the mobile radio system.

9. The method of claim 8 wherein the type events collected is any of successful handover, unsuccessful handover, reason for the unsuccessful handover and wherein target Active Set for any of said handovers is registered with said event.

10. The method of claim 6, 8 or 9 wherein the statistics or events are recorded with reference to the Active Set (AS1, AS2, AS3) serving the mobile station MS when said measurement report was received or when said event occured.

11. The method of claim 1 wherein the estimation in step b is based on signal strength measurements made by special receivers and recorded with information on the location for the measurement and the cell transmitting the signal.

12. The method of claim 1 wherein the estimation in step b includes estimating an area (ELA1, ELA2, ELA3) within which the mobile station (MS) is located when served by the Active Set.

13. The method of claim 1 wherein the estimating in step b includes prediction of wave propagation in the cells (C) of the active set (AS1, AS2, AS3) and in the cells (C) that are neighbours to the cells of the active set.

14. A system arranged to carry out the method of claim 1.

15. A system arranged to carry out the method of any of the claims 2-13.

16. Program unit on a data carrier or loadable into a management tool (DB, TL) characterised by performing the steps of:

a) predetermining the active sets (AS1, AS2, AS3) of a cellular mobile radio system, wherein a cell plan is retrieved from a database; and for each of the predetermined active sets (AS1, AS2, AS3) perform the following steps,

b) estimating the wave propagation of the cells of the active set and of cells that are neighbours to the active set;

c) estimating a location area (ELA1, ELA2, ELA3) of the mobile station when it is served by the active set;

d) predetermining a monitoring set of cells that provide a strong signal in the location area or adjacent to the location area of the mobile station.

17. Program unit as claimed in claim 16 wherein in step b) topography is retrieved from a map database (MDB) and wherein antenna sites, antenna highs and antenna gains are retrieved from a second database (DB).

18. Program unit as claimed in claim 16 wherein in step c) handover algorithm and handover thresholds are retrievable from the second database (DB).

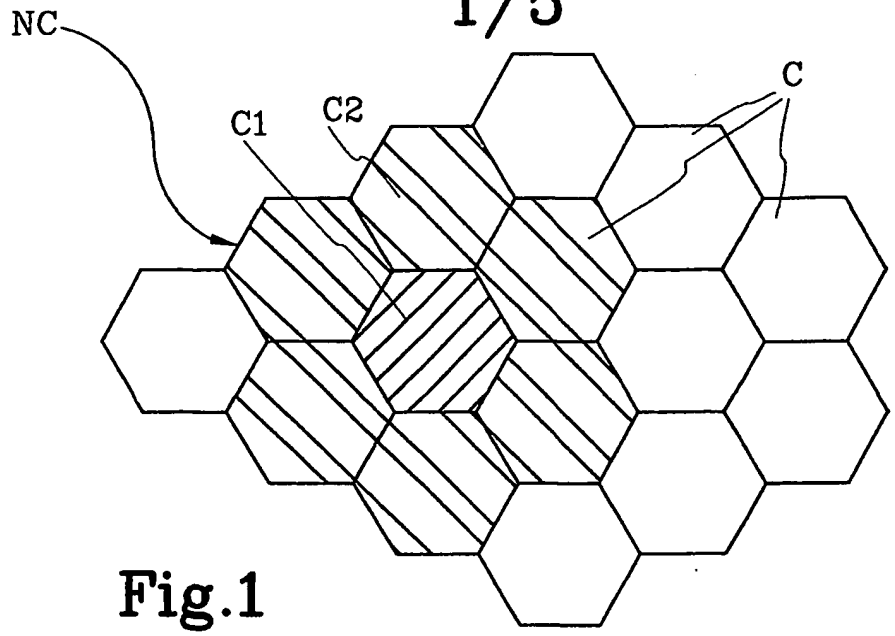

Fig.1

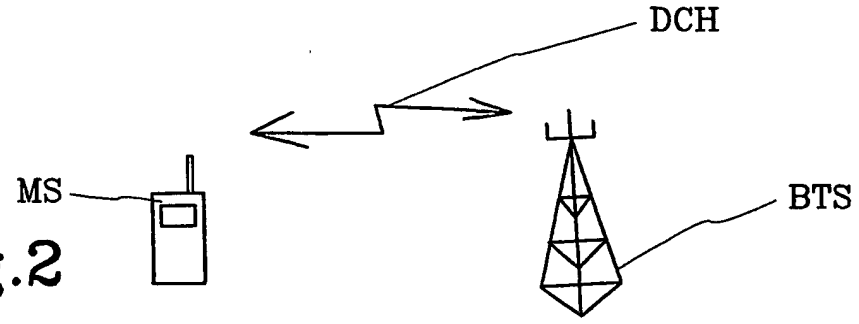

Fig.2

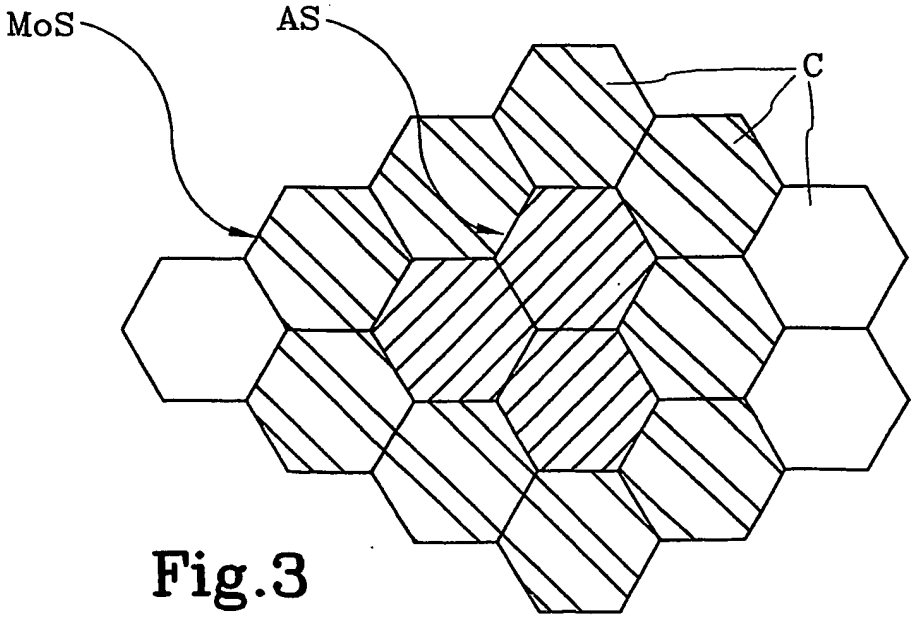

Fig.3

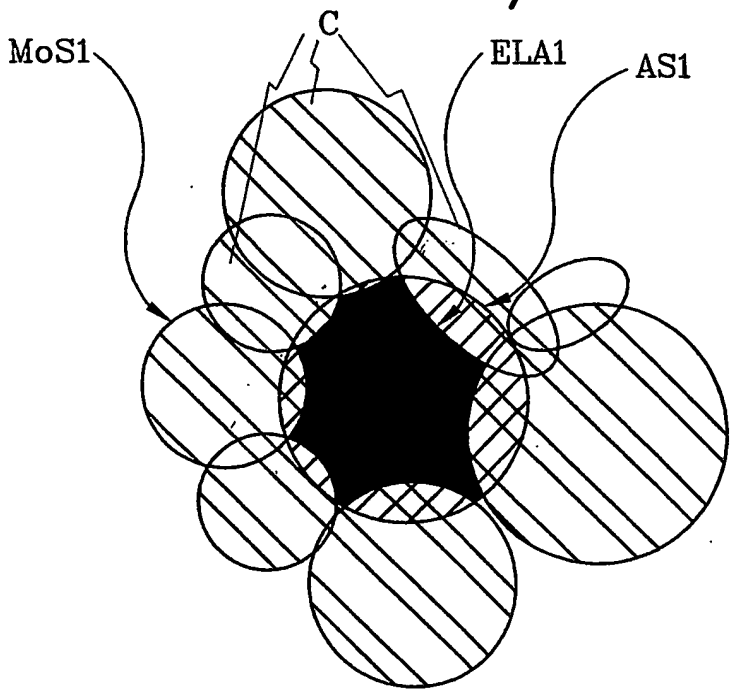

Fig.4

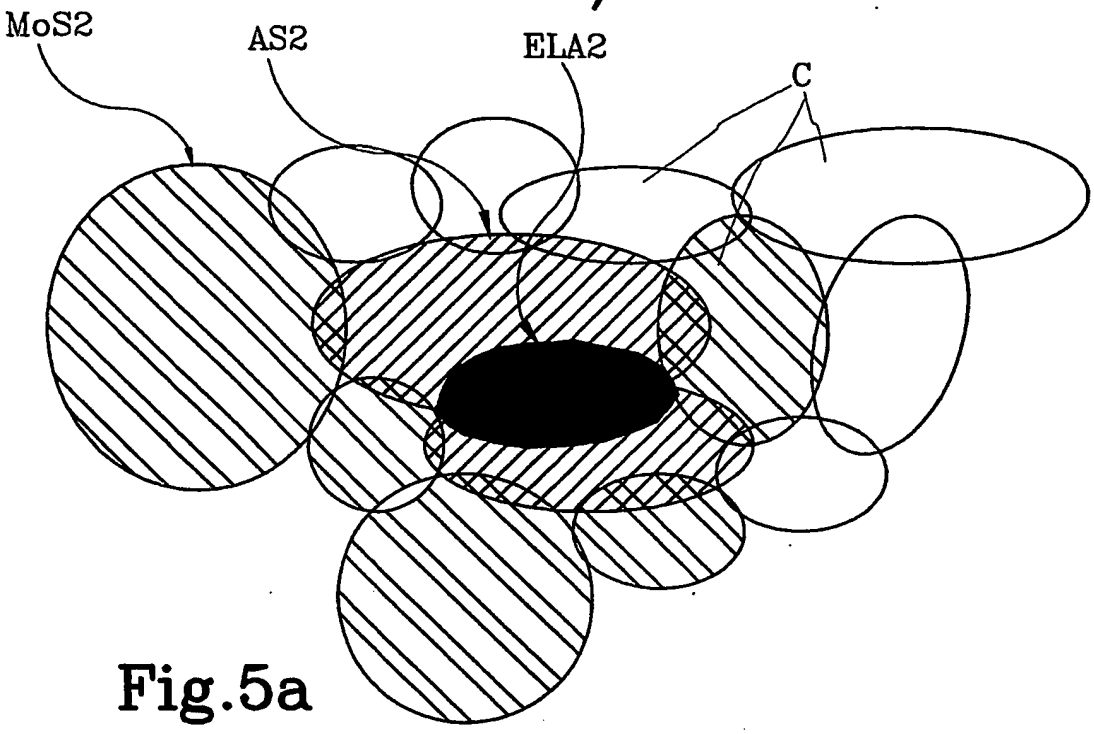

Fig.5a

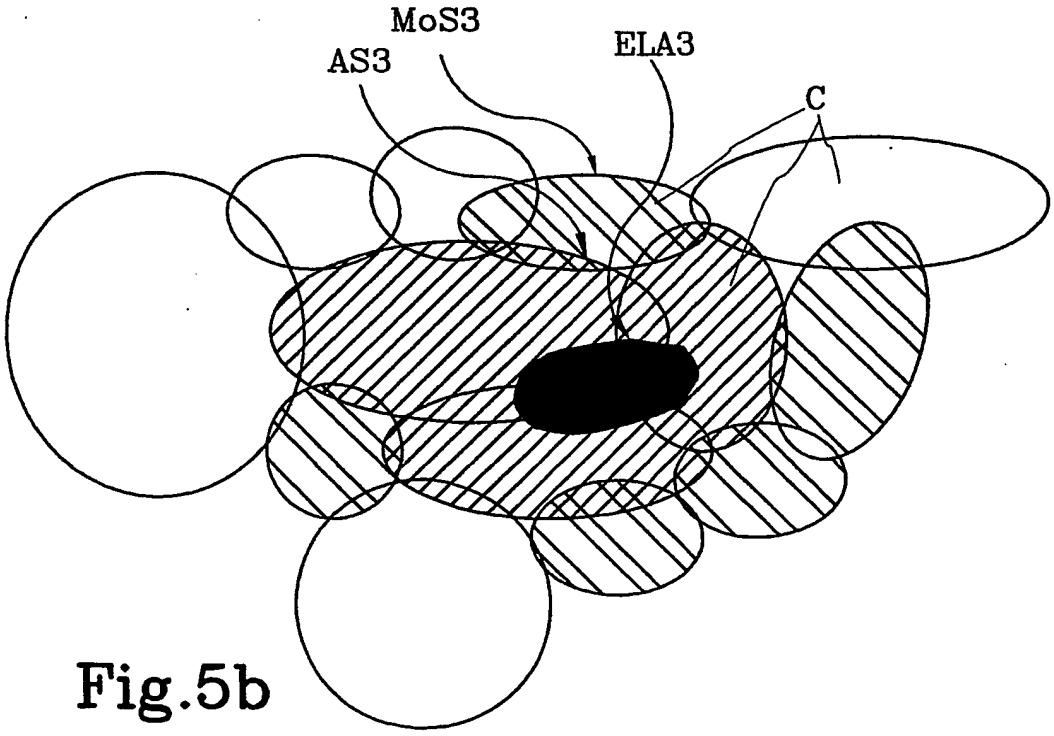

Fig.5b

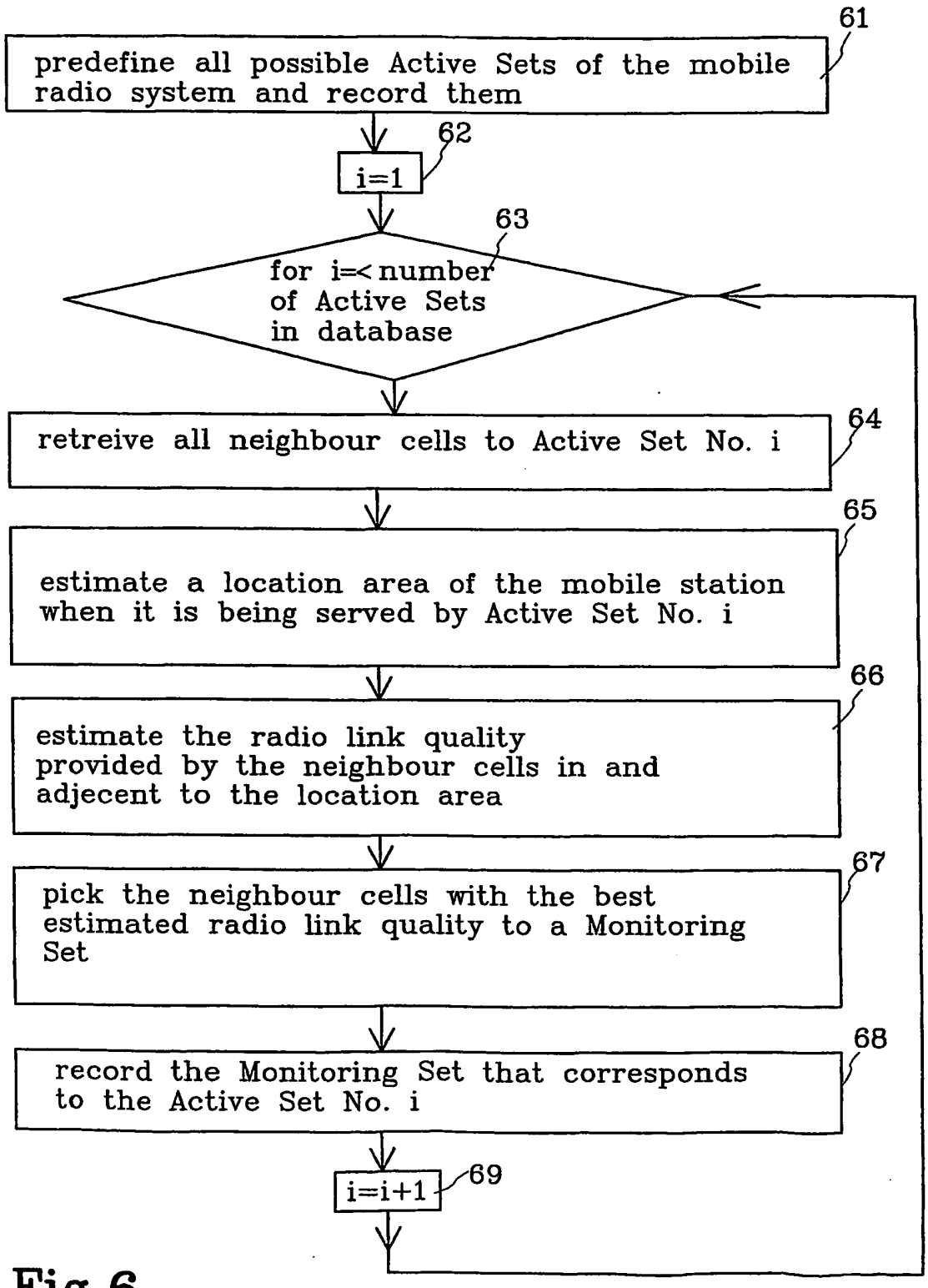
61
predefine all possible Active Sets of the mobile radio system and record them
62
i=1
63
for i=< number of Active Sets in database
64
retreive all neighbour cells to Active Set No. i
65
estimate a location area of the mobile station when it is being served by Active Set No. i
66
estimate the radio link quality provided by the neighbour cells in and adjecent to the location area
67
pick the neighbour cells with the best estimated radio link quality to a Monitoring Set
68
record the Monitoring Set that corresponds to the Active Set No. i
69
i=i+1

Fig.6

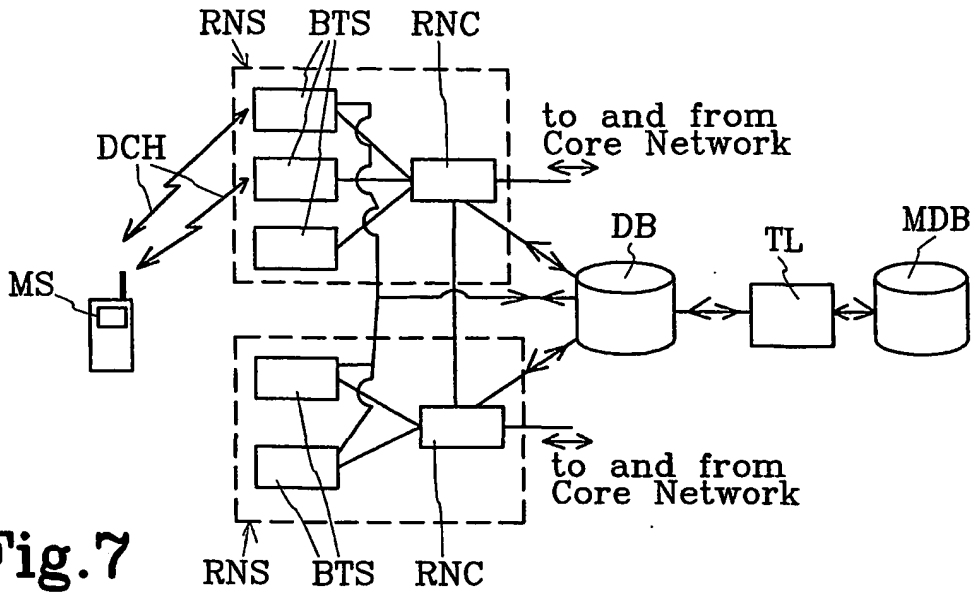
RNS
BTS
RNC
DCH
to and from
Core Network
DB
TL
MDB
MS
to and from
Core Network
RNS
BTS
RNC

Fig.7

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BLOMBERG, Petter [SE/SE]; Ågatan 20, S-172 62 Sundbyberg (SE).

(74) Agent: **MAGNUSSON, Monica**; Ericsson Radio System AB, Patent Unit Radio Access, S-164 80 Stockholm (SE).

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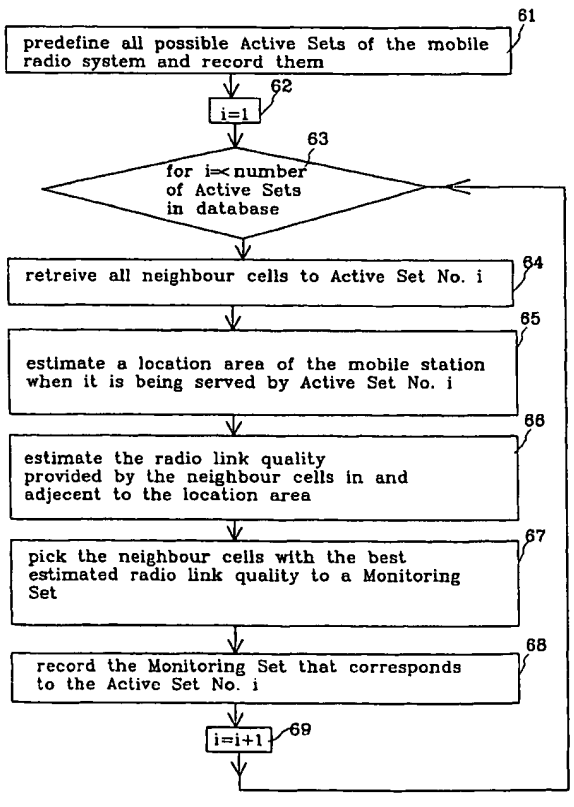
[Continued on next page]

(54) Title: A METHOD AND A COMPUTER PROGRAM RELATED TO CELL ALLOCATION MANAGEMENT IN A MOBILE RADIO NETWORK



(57) Abstract: In mobile radio system supporting soft handover several cells that supports a dedicated radio channel with a mobile station are called the Active Set (AS). The mobile station measures the radio link quality of a set of cells called Monitored Set (Mos) and that are candidates for being included in the Active Set. If many cells are included in the Monitored Set the time to make a good measure of all cells will be long, and the time to perform handover will increase. However, the right cell need be is included in the Monitored Set to become included the Active Set. According to the present invention cells that have good radio properties in the mobile location area (ELA2) are selected for the Monitored Set and because this area is more restricted than the whole service area of the cells in the Active Set, a low number of cells need be included.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/02422

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9927657 A1 (MOTOROLA INC.), 3 June 1999 (03.06.99), page 3, line 31 - page 4, line 5; page 9, line 5 - line 32, figure 4, abstract --	1-19
A	US 5640676 A (GARNCARZ ET AL), 17 June 1997 (17.06.97), column 1, line 17 - line 20; column 2, line 57 - line 62, abstract --	1-3,13,16,17
A	WO 0038466 A1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 29 June 2000 (29.06.00), abstract --	1-19

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
8 February 2002	06 -06- 2002
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Malin Söderman/js Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9819492 A2 (NORTHERN TELECOM LIMITED), 7 May 1998 (07.05.98), abstract --	1-19
A	WO 9634500 A1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)), 31 October 1996 (31.10.96), abstract -- --------	1-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

27/12/02

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9927657 A1	03/06/99	DE 19882841 T	22/03/01
		FI 20001265 A	25/05/00
		SE 0001928 A	25/07/00
		US 6195342 B	27/02/01
US 5640676 A	17/06/97	CA 2193690 A	14/11/96
		EP 0770313 A	02/05/97
		FI 965221 A	27/12/96
		JP 10503353 T	24/03/98
		KR 232266 B	01/12/99
		WO 9636190 A	14/11/96
WO 0038466 A1	29/06/00	AU 2133500 A	12/07/00
		BR 9916451 A	04/09/01
		EP 1142418 A	10/10/01
WO 9819492 A2	07/05/98	US 5946621 A	31/08/99
WO 9634500 A1	31/10/96	AU 5519396 A	18/11/96
		US 6073010 A	06/06/00